

LONG RECURRENCE RECORDS FROM THE WASATCH FAULT ZONE, UTAH

Program Element II.5: Identify active faults, define their geometry, and determine the characteristics and dates of past earthquakes

Final Technical Report

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1. ABSTRACT

The Wasatch fault "megatrench" was excavated in Sept. 1999 across an 18 m-high double-scarp of the Salt Lake City segment of the Wasatch fault zone (WFZ), 1 km north of the mouth of Little Cottonwood Creek. The trench and accompanying auger hole exposed 26 m of vertical section, roughly 4 times that of the typical trench on the WFZ. Each of the two fault scarps transected were underlain by normal faults with 7-9.5 m of vertical displacement measured on the top of Bonneville-age lake beds (ca. 15,500 years old). Each fault was fronted by 3-4 colluvial wedges, indicating 3-4 post-Bonneville faulting events on each fault. The one surprise in the trench was the existence of a thick buried soil developed atop the lake beds and underlain by scarp-derived colluvium. This soil argues for a long period of fault inactivity between ca. 9,000 years ago and 15,500 years ago. That time span is roughly 4 times as long as the typical intervals between major earthquakes on this segment of the WFZ. The quiescent interval could be either an irregularity typical of the long-term behavior of the WFZ, or a response to the drying up of Lake Bonneville between 15,000 years ago and ca. 11,000 years ago, which relieved a huge weight on the downthrown fault block of the WFZ. If it was an unloading effect, it died out by the time of Event W, and that it has not affected the regular 1300-1400 year recurrence cycle since that time. Therefore, we do not propose to favor or disfavor any of McCalpin and Nishenko's recurrence models based on the long recurrence times observed while the lake was drying up.

However, we can apply the results of some more recent recurrence studies to the likelihood of the various recurrence models. For example, the highest 100-year conditional probability calculated by McCalpin and Nishenko (1996) was 57%, based on a Weibull model of recurrence with a mean of 1328 years and a COV of only 0.04. By comparison, conditional probabilities based on lognormal models with COVs of 0.21 and 0.5 indicated probabilities of 22% and 11%, respectively (Table 5). So, is the COV of long-term recurrence on the SLC segment closer to 0.04, 0.21, or 0.5?

McCalpin and Slemmons (1998) inventoried all published paleoseismic chronologies that contained 3 or more well-dated events. They found that, as a group, worldwide normal faults with a large span of slip rates and mean recurrences tended to have an average COV of recurrence of 0.35. The same data set for all fault types yielded an average COV of recurrence of 0.36. In addition, the more paleoearthquakes that had been dated at a local trench site, the closer the COV of that local recurrence series approached 0.36. McCalpin and Slemmons argued that a relatively short recurrence series at a site (say, containing only 3-4 events, or 2-3 recurrence intervals) could yield a wide possible range of recurrence COVs, ranging from ca. 0.04 to 0.8. However, the site chronologies with successively more events tended to have COVs that converged on the value 0.36. They further argued that, for the purposes of making conditional probability estimates, it would be preferable to use the value COV=0.36 rather than use an "apparent" COV value from a short (3-4 event) recurrence series.

Their conclusions suggest that we should probably not lend much weight to the probability estimate of 57% in Table 5, which is based on a COV=0.04 from only 4 events on the SLC segment. Instead, we should probably assume a long-term recurrence COV of 0.36 for the SLC segment. Note that 0.36 falls almost exactly halfway between the COVs of 0.21 and 0.5, which resulted in probability estimates of 22% and 11%, respectively, for the next 100 years. If we assume that conditional probability varies linearly with COV over this relatively small range, then an assumed recurrence COV=0.36 would imply a conditional probability of 16% for $M > 7$ earthquakes in the next 100 years.